

Sub
B1

1. An apparatus within a pipelined microprocessor for
2 forwarding store instruction results to a pipeline
3 stage for execution of a load instruction, the
4 apparatus comprising:

5 a result forwarding cache (RFC), for storing a
6 plurality of store instruction results;
7 comparison logic, for comparing a load address of the
8 load instruction with a plurality of store
9 addresses associated with said plurality of store
10 instruction results to generate an address match
11 signal; and
12 control logic, configured to receive said match signal
13 and selectively forward one of said plurality of
14 store instruction results from said RFC to the
15 pipeline stage in response to said match signal.

1 2. The apparatus of claim 1, wherein said plurality of
2 store instruction results comprise data to be stored
3 from the microprocessor into a memory attached thereto.

1 3. The apparatus of claim 1, wherein said load address
2 specifies a location of data to be loaded into the
3 microprocessor from a memory attached thereto.

1 4. The apparatus of claim 1, wherein said RFC comprises a
2 plurality of storage elements for storing a
3 predetermined number of instruction results.

Cont
B1
1 5. The apparatus of claim 4, wherein said instruction
2 results are received by said RFC from an execution unit
3 of the microprocessor.

1 6. The apparatus of claim 4, wherein said plurality of
2 storage elements store said predetermined number of
3 instruction results in a first-in-first-out manner.

1 7. The apparatus of claim 4, wherein said predetermined
2 number of instruction results is five.

1 8. The apparatus of claim 1, wherein said load address and
2 said plurality of store addresses comprise virtual
3 addresses.

1 9. The apparatus of claim 8, wherein said virtual
2 addresses comprise x86 linear addresses.

1

1 10. An apparatus for forwarding storehit data within stages
2 of a pipelined microprocessor, the apparatus
3 comprising:

4 a result forwarding cache (RFC), configured to forward
5 a first plurality of store instruction results;
6 a data unit, configured to forward a second plurality
7 of store instruction results; and
8 selection logic, coupled to said RFC and said data
9 unit, for selectively providing one of said first
10 and second plurality of store instruction results
11 to a stage of the microprocessor pipeline
12 executing a load instruction.

1 11. The apparatus of claim 10, wherein said load
2 instruction comprises a load address for specifying an
3 address of data to be loaded into the microprocessor,
4 wherein said selection logic is configured to forward
5 one of said first and second plurality of store
6 instruction results only if said load address matches
7 one or more of a first and second plurality of store
8 addresses corresponding to said first and second
9 plurality of store instruction results.

1 12. The apparatus of claim 11, wherein selection logic
2 forwards said first plurality of store instruction
3 results forwarded by said RFC at a higher priority than

4 said second plurality of store instructions results
5 forwarded by said data unit if said load address
6 matches both one or more of said first plurality of
7 store addresses and one or more of said second
8 plurality of store addresses.

1 13. The apparatus of claim 11, further comprising:
2 comparison logic, coupled to said selection logic, for
3 comparing said load address with said first and
4 second plurality of store addresses to determine
5 whether said load address matches one or more of
6 said first and second plurality of store
7 addresses.

1 14. The apparatus of claim 11, wherein said data unit is
2 configured to forward said second plurality of store
3 instruction results from a plurality of store buffers
4 of the microprocessor.

1 15. The apparatus of claim 14, wherein said plurality of
2 store buffers is configured to store said second
3 plurality of store instruction results while said
4 second plurality of store instruction results are
5 written to a memory coupled to the microprocessor.

1 16. The apparatus of claim 14, wherein said data unit is
2 configured to forward a newest one of said second
3 plurality of store instruction results if said load

Cont
(3)
4 address matches more than one of said second plurality
5 of store addresses.

1 17. The apparatus of claim 11, wherein said RFC is
2 configured to forward a newest one of said first
3 plurality of store instruction results if said load
4 address matches more than one of said first plurality
5 of store addresses.

1

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 18. An apparatus for detecting storehit conditions in a
2 pipelined microprocessor in a hierarchical manner, the
3 apparatus comprising:

4 first comparison logic, for comparing a load
5 instruction load address in a first stage of the
6 pipeline with a first plurality of store addresses
7 of first store instruction data in a plurality of
8 stages of the pipeline subsequent to said first
9 pipeline stage;

10 second comparison logic, for comparing said load
11 address with a second plurality of store addresses
12 of second store instruction data in a plurality of
13 store buffers of the microprocessor; and

14 control logic, coupled to said first and second
15 comparison logic, configured to determine which of
16 said first and second store instruction data is
17 newest based on said first and second comparison
18 logic comparing.

1 19. The apparatus of claim 18, wherein said first
2 comparison logic is configured to compare virtual
3 addresses.

1 20. The apparatus of claim 18, wherein said second
2 comparison logic is configured to compare physical
3 addresses.

1 21. An apparatus for speculatively forwarding storehit data
2 in a microprocessor pipeline, the apparatus comprising:
3 a plurality of virtual address comparators, for
4 comparing a load address with a plurality of store
5 addresses to generate a virtual match signal;
6 a plurality of physical address comparators, for
7 comparing said load address with said plurality of
8 store addresses and generating a physical match
9 signal; and
10 control logic, for receiving said virtual and physical
11 match signals and generating a stall signal for
12 stalling the pipeline if said physical match
13 signal indicates a match between said load address
14 and one of said plurality of store addresses but
15 said physical match signal indicates no match.

1 22. The apparatus of claim 21, further comprising:
2 a data unit, configured to forward correct data
3 specified by the load address to replace
4 previously forwarded storehit data;
5 wherein said control logic is configured to deassert
6 said stall signal after said data unit forwards
7 said correct data.

1 23. A pipelined microprocessor for speculatively forwarding
2 storehit data from a first pipeline stage to a second
3 pipeline stage, wherein the storehit data is specified
4 by a load address in the second stage, comprising:
5 address region logic, configured to receive the load
6 address and generate a match signal to indicate
7 whether the load address is within one of a
8 plurality of non-cacheable address regions of the
9 microprocessor address space stored therein;
10 forwarding logic, for forwarding the storehit data from
11 the first stage to the second stage during a first
12 clock cycle; and
13 control logic, configured to receive said match signal
14 and to assert a stall signal during a second clock
15 cycle to stall the pipeline if the load address is
16 within one of said plurality of non-cacheable
17 address regions.

1 24. The microprocessor of claim 23, further comprising:
2 a bus interface unit, for receiving data from a bus
3 coupled to the microprocessor, said bus further
4 coupled to a system memory and a plurality of
5 peripheral devices; and
6 at least one response buffer, operatively coupled to
7 the second stage, for receiving load data
8 specified by the load address from said bus

9 interface unit, and for providing said load data
10 to the second stage to replace the storehit data
11 if the load address is within one of said
12 plurality of non-cacheable address regions.

1 25. The microprocessor of claim 23, wherein said plurality
2 of non-cacheable regions stored in said address region
3 logic are software-programmable.

1

1 26. A method for forwarding storehit data in a
2 microprocessor pipeline, the method comprising:
3 detecting a storehit condition, wherein a load
4 instruction in a stage of the pipeline specifies
5 data generated by a previous store instruction,
6 wherein said data is still present in the
7 pipeline;
8 determining whether said data is present in a result
9 forwarding cache of the microprocessor;
10 selectively forwarding said data from said result
11 forwarding cache to said stage if said data is in
12 said result forwarding cache; and
13 selectively forwarding said data from a data unit of
14 the microprocessor to said stage if said data is
15 not in said result forwarding cache.

1 27. The method of claim 26, further comprising:
2 storing results data of each store instruction executed
3 by an execution unit of the microprocessor in said
4 result forwarding cache.

1 28. The method of claim 26, wherein said detecting said
2 storehit condition comprises:
3 comparing an address of said data specified by said
4 load instruction with a plurality of store

5 instruction result data addresses stored in the
6 pipeline below said stage; and

7 determining said address matches one or more of said
8 plurality of data addresses.

1 29. The method of claim 26, wherein said determining
2 whether said data is present in said result forwarding
3 cache comprises:

4 comparing an address of said data specified by said
5 load instruction with a plurality of store
6 instruction result data addresses stored in a
7 predetermined number of stages of the pipeline
8 below said stage;

9 wherein said predetermined number equals a number of
10 result entries in said result forwarding cache.

1

1 30. A method for speculatively forwarding storehit data in
2 a microprocessor pipeline, the method comprising:
3 speculatively forwarding storehit data from a first
4 stage to a second stage of the pipeline based on a
5 virtual address comparison between a load address
6 and a plurality of store addresses;
7 detecting a virtual aliasing condition with respect to
8 said load address and one of said plurality of
9 store addresses based on a physical address
10 comparison between said load address and said
11 plurality of store addresses after said
12 speculatively forwarding; and
13 stalling the pipeline in response to said detecting
14 said virtual aliasing condition.

1 31. The method of claim 30, further comprising:
2 forwarding correction data from a third stage of the
3 pipeline to said second stage after said stalling
4 the pipeline; and
5 unstalling the pipeline after said forwarding said
6 correction data.

1 32. The method of claim 30, wherein said virtual aliasing
2 condition comprises a condition wherein said load
3 address and one of said plurality of store addresses
4 are different, but wherein said load address and said

5 one of said plurality of store addresses map to an
6 identical physical address.

1 33. The method of claim 30, wherein said storehit data
2 comprises a store instruction result within the
3 pipeline having an identical physical store address as
4 said physical load address.

1 34. A method for speculatively forwarding storehit data in
2 a microprocessor pipeline, the method comprising:
3 detecting a storehit condition by comparing a load
4 address with a plurality of store addresses;
5 speculatively forwarding storehit data in response to
6 said detecting said storehit condition;
7 determining said load address is within a non-cacheable
8 address region subsequent to said speculatively
9 forwarding; and
10 stalling the pipeline in response to said determining
11 said load address is within a non-cacheable
12 address region.